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The Relationship between Precipitation and Stream Flow on a Typical Southeast Alaska Stream

Detention storage and ground-water storage of watersheds in Southeast Alaska are not great. Watersheds are characterized by shallow soil mantles which generally overlay unfractured bedrock. Stream base flow is small. Annual precipitation in the region is high; ranging from approximately 165 inches in the southern portion to 60 inches in the northern portion. Some rainfall occurs every month of the year.

The combination of heavy precipitation and small water-storage capacity of the watersheds results in a fairly unstable stream discharge pattern; especially where watersheds do not contain flow-regulating lakes. Streamflow fluctuates quite rapidly between maximum and minimum values within relatively short periods of time. The flashy nature of storm runoff is clearly seen by an examination of the stream hydrograph of Maybeso Creek[1/] shown in Figure 1. The stream rose from a height of 0.8 feet to a height of 2.6 feet within a few hours after the first rain fell on the watershed.

The question is often asked, "How much time-lag exists between peak precipitation intensities and peak stream runoff?" Of special interest is the time-lag associated with storms on streams whose watersheds are not in a saturated condition from previous periods of precipitation. To answer this question, a detailed analysis was made of the storm shown in Figure 1 which occurred August 9 and 10, 1953, and produced 1.25 inches of rain[2/] in a 16-hour period. This storm was selected because no rain had fallen during the preceding 12 days and stream discharge probably represented approximate base flow. The analysis is made easier because this period is not confounded by a series of storms whose cause and effect would be difficult to separate. In addition, hourly precipitation records were available for this period.

The close relationship which exists between precipitation and stream discharge is shown in Figure 2. The streamflow hydrograph follows very closely the general outline made by hourly precipitation with a displacement of approximately 9 hours. Precipitation resulted in a rapidly increasing discharge rate which rose from 0.9 cubic feet per second per square mile of watershed to 20.5 cubic feet per second per square mile. The time-lag between peak precipitation intensity (0.28 inches between 10 p.m. and 11 p.m.) and peak stream discharge (occurring at 7 a.m. the following morning) was approximately 9 hours. The time-lag associated with saturated watersheds is considerably less (1).

Surficial runoff accounts for a high proportion of the total precipitation falling on the watershed. The storm of August 9 and 10 deposited approximately 2.9 million cubic feet of rain per square mile of watershed. Nine hundred thousand cubic feet of this was lost as surficial runoff within 24 hours following cessation of the rain. This amounted to a runoff of approximately 28 percent of the total storm precipitation after deducting the small amount attributable to stream base flow. An additional runoff of only 11 percent occurred during the following 72-hour period and brought stream

1/ Located at 12 Mile Arm, Hollis, Alaska.

2/ As measured by a single rain gage located in the Maybeso Creek drainage at an elevation of approximately 300 feet.

discharge down to a point just slightly greater than base flow.3/ This is a high percentage runoff in view of the fact that precipitation fell on an unsaturated watershed. Considerably more surficial runoff is associated with saturated drainage areas. Zach (1) found, in an analysis of two storms occurring in the Maybeso Creek and Harris River drainages, that storm runoff from saturated watersheds accounted for 93 to 112 percent of the precipitation measured at sea-level.4/

This preliminary analysis, part of a study to determine the effect of logging on salmon spawning streams, indicates that the Maybeso Creek watershed, which is representative of many forested drainages in Southeast Alaska, is highly sensitive to rainfall intensity. Small amounts of precipitation may cause minor peaks in stream discharge; large amounts generally result in flood flows. The time interval between peak precipitation and peak runoff is of relatively short duration. Low ground-water storage capacity of the watershed results in high surficial runoff. This condition prevails on forested watersheds prior to any change in the pattern of land-use.

3/ A storm occurring on August 14 raised the stream level and prevented calculation of the length of time required for runoff to equal base flow.

4/ It is not uncommon for precipitation measured at low-elevation stations to be less than stream discharge as rainfall at higher altitudes is usually greater than it is at sea-level.

Literature Cited

(1) Zach, L. W. Effect of rainfall on stream flow in Southeast Alaska. Tech. Note No. 4, Alaska Forest Research Center, 3 pp, 1950.

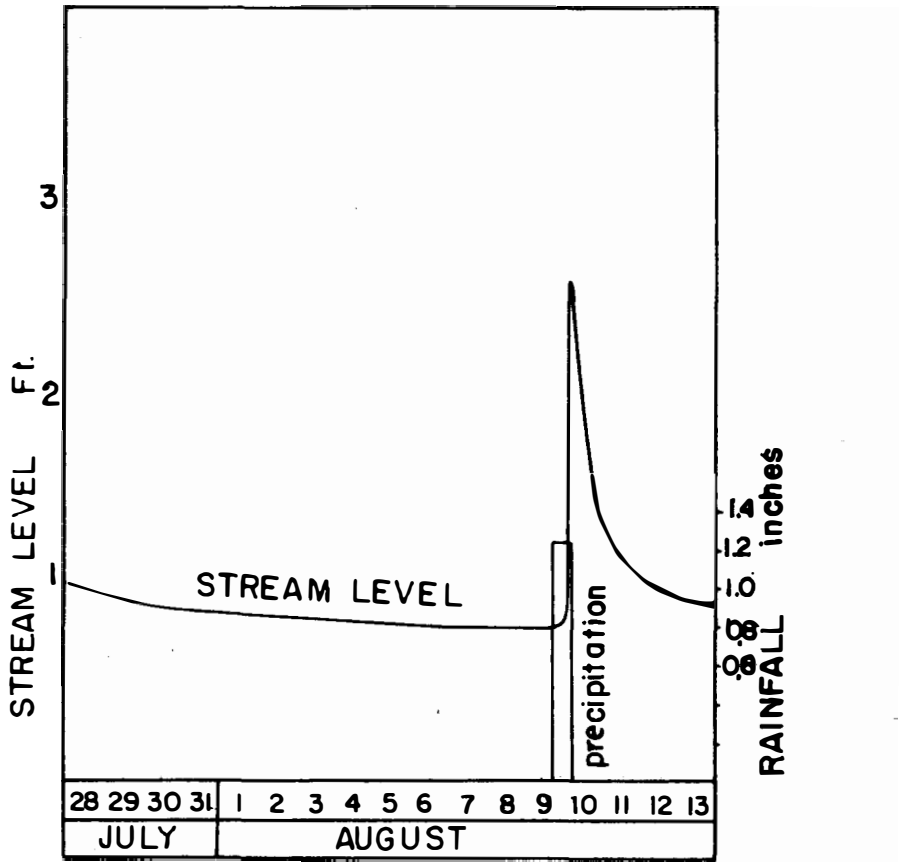

Figure 1. Stream level and precipitation, Maybeso Creek. Period July 28 to August 13, 1953.

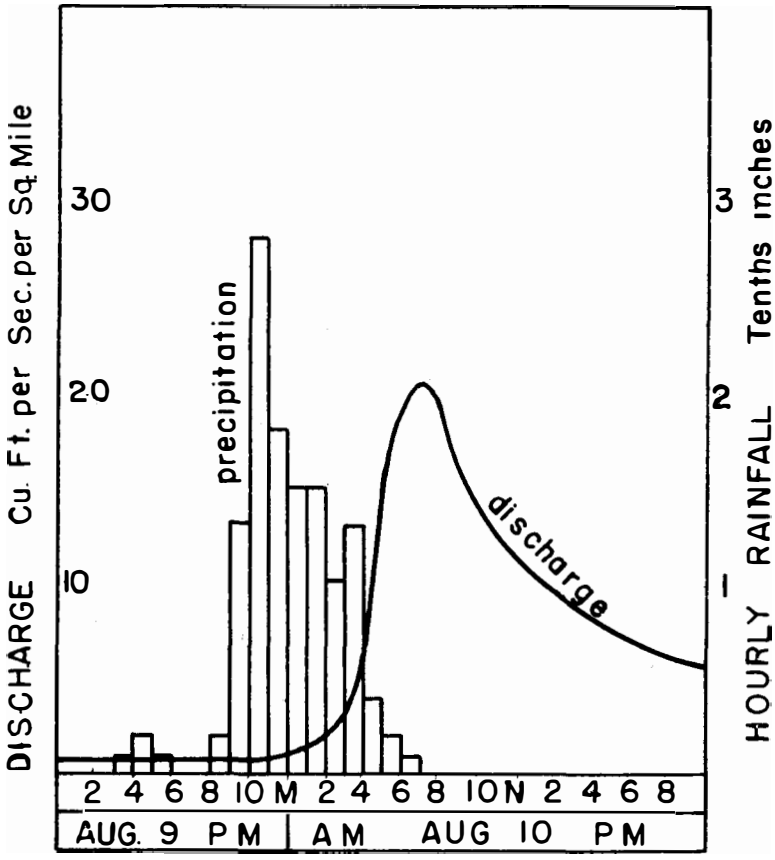

Figure 2. Streamflow hydrograph of Maybeso Creek showing relationship between discharge and hourly precipitation for the storm of Aug. 9–Aug. 10, 1953.

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